PhD Project Advertisement

Project title: Automated monitoring of health and welfare in groups of pigs using evidential reasoning and video-analytics

Project No: FBS2023-37-McLaughlin-qs

Lead supervisor: Niall McLaughlin, Electronics, Electrical Engineering and Computer Science, Queen's University Belfast

Email: n.mclaughlin@qub.ac.uk

Co-supervisors:
Alasdair Cook, University of Surrey; Ilias Kyriazakis, Queen's University Belfast

Project description:

The overall aim of this studentship is to use artificial intelligence (AI) to build an early warning system for pig health. To do this we will use AI to analyse a video stream of a pig pen. The AI system will monitor the social interactions between pigs within a pen as well as their individual behaviours. The AI system will build up a picture of the group behaviour within the pen over time and identify deviations from the normal pattern. The hypothesis we want to explore is that subtle changes in group behaviour can indicate future health and welfare problems. We aim to develop an early warning system to alert farmers so that they can quickly intervene at the first sign of health and welfare problems to prevent them from becoming more serious.

On a commercial scale, human observation of subtle changes in group dynamics that may indicate early-stage disease or aberrant behaviour is impractical as such observations are time-consuming and modern pig systems deal with hundreds or thousands of individuals simultaneously. Instead, we will use AI to address this problem. A video camera will monitor the pen, and our AI computer-vision software will track the movements of each pig, recognise activities such as eating and drinking and recognise interactions between pigs. To combine all this information to give a complete picture of the group-level behaviour we will use Evidential Reasoning Networks (ERN). These networks provide a principled way to combine multiple sources of uncertain evidence, such as the activities of multiple individual pigs, to give a coherent picture of the world. By combining evidence related to the behaviour of multiple individual pigs, together with their interactions, we aim to achieve an understanding of the pattern of behaviours at the group level. Detecting subtle changes at the group level behaviour will form the basis for the alerts generated by our early warning system.

The following activities will be performed by the student:

1) Build on and extend existing computer-vison tools for monitoring animal behaviour. The aim will be to develop a real-time tracker and activity recognition system capable of long-term operation. The system will produce a long-term record of the location of each pig and its activities such as social interactions, play, and feeding and drinking events. Current approaches can only be applied for limited time periods as they require costly offline non-real-time processing.
2) Given a dataset of long-term pig behaviour information, we will apply ERN to combine trajectory information, provided by the tracker, together with deep-learning-based event and activity detection methods such as animal posture, feeding and drinking behaviours and social interactions. We will design evidential networks to reason about and combine multiple sources of low-level evidence in order to trigger alerts related to group-level behavioural changes.
3) To detect group-level interactions/events, while reducing reliance on manually labelled datasets, we will explore ways to automatically data-mine long-term behavioural datasets. To do this we will develop a statistical model for normal pig behaviour and develop methods to detect whether the current behaviour is deviating from normal. Changes in group behaviour will then trigger alerts giving warnings of welfare events.
4) We will finally combine all our components together to develop a complete system for understanding the group behaviour of pigs. The system will be capable of continuously monitoring animal welfare and health in real time

in order to trigger alerts and enable early intervention if needed. In addition to the obvious health and welfare benefits, this system will have the potential to open a new field of research, enabling data mining to be applied to newly available large datasets of animal behaviour in ways that have not been possible before.

Training opportunities:

This is a cross-disciplinary project where the training opportunities will be adapted to the skills and expertise of the student appointed. A computer science student will be offered the chance to attend modules of the MSc course in Animal Behaviour and Welfare (QUB), to obtain an understanding of the behaviours that underlie the two health challenges to be addressed. Alternatively, a student with a biological background will be trained on modules provided by the MSc in Data Analytics (QUB), especially in Machine learning, Evidential Reasoning Networks and Generative adversarial networks. In both cases, the candidate will acquire a rare combination of technical, scientific and hands-on skills that are highly valued in both industry and academia.

The student will benefit from the association through his/her supervisors with two major initiatives: Global Innovation Institute (GII, QUB) and vHive at University of Surrey, both aiming to lead the development and application of transformational digital and data analytics tools to advance the well-being of animals and the resilience of their systems. As a member of these initiatives, the student will have access to the latest development in these fields. The student will spend 2x3 months placements at Surrey to benefit from this association and acquire novel skills.

Student profile:

This project would be suitable for candidates who have an upper second-class degree in a related field (e.g., animal science, veterinary, computer science, mathematics, or physics), and interested in the application of novel Artificial Intelligence methods to a biological problem. The ideal candidate will have strong problem-solving and ideally computer programming abilities. They will be mathematically proficient. They will have skills in reviewing literature, writing technical documents, teamwork and time management. They will be highly motivated to learn state-of-the-art in computer vision techniques and be ready to adapt and modify these techniques to the biological context.

References:

Alameer, A., Kyriazakis, I., Dalton, H.A., Miller, A.L. and Bacardit, J., 2020. Automatic recognition of feeding and foraging behaviour in pigs using deep learning. biosystems engineering, 197, pp.91-104.

McLaughlin, N., del Rincon, J.M. and Miller, P., 2017. Video person re-identification for wide area tracking based on recurrent neural networks. IEEE Transactions on Circuits and Systems for Video Technology, 29(9), pp.2613-2626.

Hong, X., Huang, Y., Ma, W., Varadarajan, S., Miller, P., Liu, W., Jose Santofimia Romero, M., Martinez del Rincon, J., & Zhou, H. (2016). Evidential event inference in transport video surveillance. Computer Vision and Image Understanding, 144 , 276–297.

Funding particulars:

For up to date information on funding eligibility, studentship rates and part time registration, please visit the FoodBioSystems website.